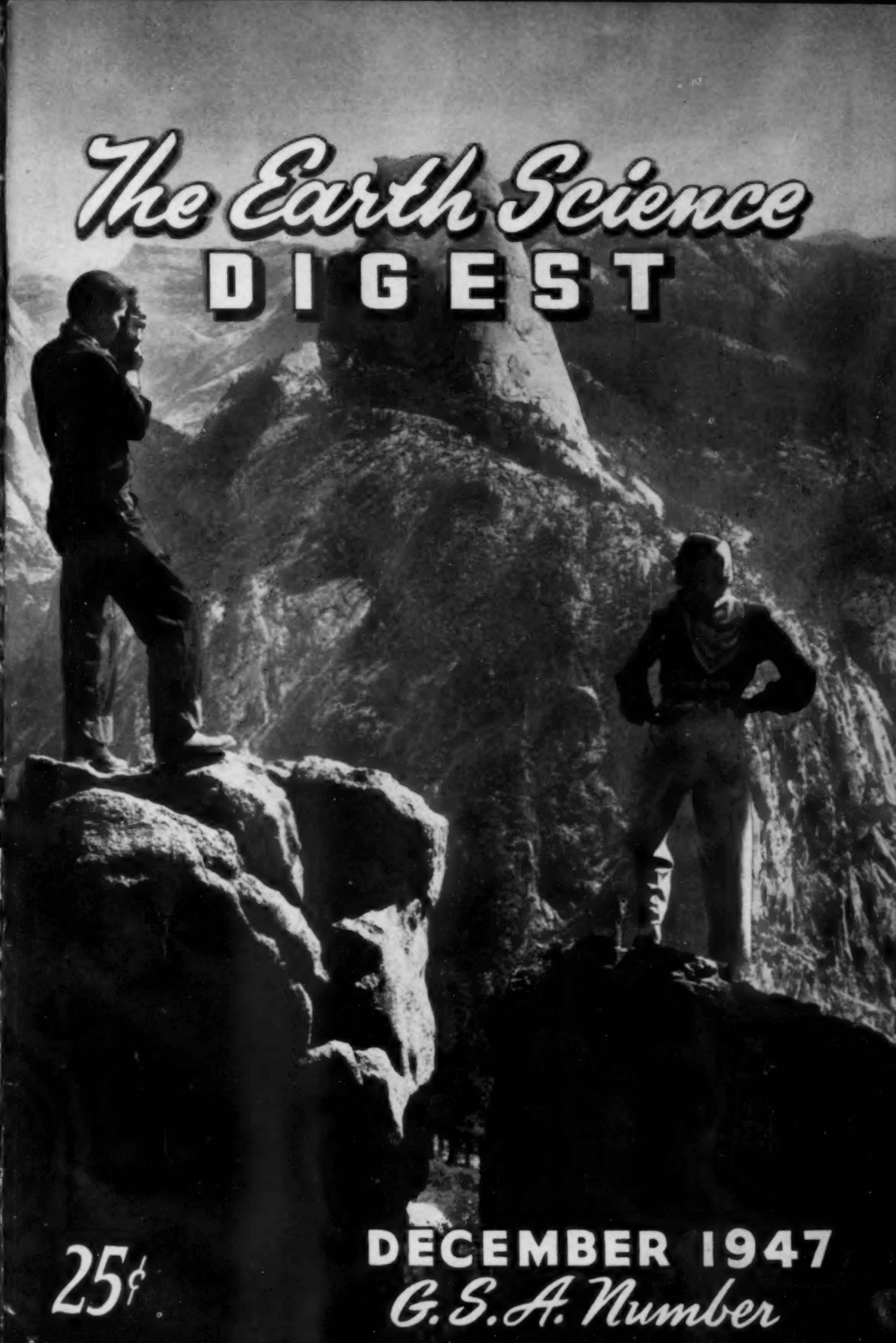
The Earth Science DIGEST



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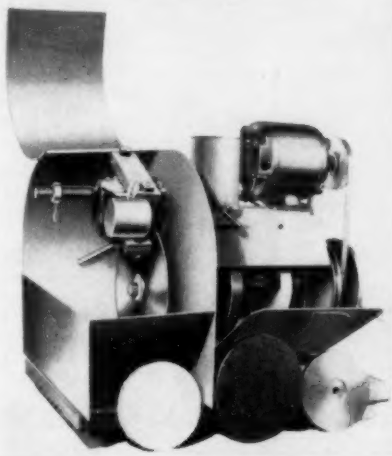

The Earth Science Digest

Box 581 Ann Arbor, Michigan

A magazine devoted to the advancement of the geological sciences.

Hendrik P. Zuidema, Editor

THE EARTH SCIENCE DIGEST is open to articles of geologic interest. Manuscripts, photographs and sketches will be returned if accompanied by ample first-class postage.

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Alice L. Hart, Circulation and Business Manager

Vol. II December - 1947 No. 4

Contents

—Photo by Harry Rowed, Jasper Park.

CANADA WELCOMES THE G.S.A.

NATIONAL MUSEUM
OF CANADA

CANADA

DEPARTMENT
OF
MINES AND RESOURCES
MINES AND GEOLOGY BRANCH

Ottawa, December 20, 1947.

The Geological Survey of Canada is the Government's oldest scientific institution, having been founded in 1842, twenty-five years prior to Dominion Confederation. In 1942 it thus completed its 100 years of continuous service. It had been planned that some recognition should be taken of this important milestone. The Geological Society of America was therefore invited to hold its Annual Meeting of that year in Ottawa to assist in the celebration ceremonies. The Society accepted the invitation but later, owing to wartime restrictions enforced by the Governments of both the United States and Canada, this anniversary celebration unfortunately had to be cancelled.

Shortly after the termination of hostilities in 1945, the Geological Society of America inquired whether the invitation to hold an Annual Meeting in Ottawa still held, and were advised by the Geological Survey of Canada that the year 1947, as the 105th Anniversary of the founding of the Survey, would be a very suitable date on which to hold the postponed centenary meeting. The Society accepted this invitation and its 60th Annual Meeting is therefore being held in Ottawa, December 29-31, 1947.

The Geological Survey of Canada, the citizens of Ottawa, and the people of Canada join in extending a most cordial welcome to our visitors from across the border and trust that their stay in Ottawa will be greatly enjoyed.

F. J. Alcock

Curator.

The Dominion honored the commander-in-chief of the Allied forces in World War II by renaming Castle Mountain, near Banff, Mt. Eisenhower.

WHAT HAPPENED TO THE DINOSAURS?

A Paleontologist Reviews Their Rise and Fall— And Bids Mankind to Take Heed

Tyrannosaurus engages *Triceratops* in combat at the edge of a Cretaceous swamp in western North America, while a small dinosaur of the time flees from the scene of battle.

RUSSELL C. HUSSEY
University of Michigan

Nearly every mineral collector at one time or another either has had a scrap of dinosaur bone among his collections or has seen the remains of dinosaurs in the great museums of this country. Dinosaur bone frequently still shows the structure of the living animal, even to the network of minute blood vessels and nerve canals, due to the replacement of the fine bone structure by mineral matter, usually silica, following the burial of the animals.

A bone once cataloged in one of our large museums as a bison horn core was discovered to be, after a cross-section had been cut and examined, the horn of one of the ceratopsians, or horned group of dinosaurs. The evidence of reptilian structure was there.

In these fragments we have the remains of a once-mighty race which dominated the earth for 140 millions of years, 140 times as long as man, as such, has been on this globe. We have far to go to equal the record of the dinosaurs.

All living things are to a greater or lesser degree the prisoners of their environment, no matter how well they appear to be equipped by nature at any one time in their racial life, man not excepted. Perhaps we should look into the lives of the dinosaurs and gain some idea about whether we are facing a similar destiny.

There are no dinosaurs living today, although the climatic and other environmental conditions, such as food supply, now found in the upper Amazon Valley, would very well permit some of the last of the race to linger there. At least no human has ever proven that he has seen a dinosaur lurking in the green depths of the modern jungles.

The extinction of the dinosaurs is an intriguing problem. Why did they die off? Let us look at the fossil record, which gives us a splendid picture of the rise and fall of these "terrible reptiles," which is what the word "dinosaur" means. But we must remember that not all dinosaurs were either huge or ferocious. Some were small and inoffensive, timid and furtive creatures, as are the small lizards of today.

Yet, all passed from the scene, not at once, but through the long ages of the Era of Reptiles, and none remained after the great crustal disturbances which gave rise to the Rocky Mountains some 60 millions of years ago. The mammals, a new dynasty of warm-blooded, hair-covered, milk-secreting creatures, then assumed control of the terrestrial realm.

The reptiles, of which the dinosaurs made up two large and diverse groups, did not come into control with sound and fury and speed. They made a modest entry while the world of life only slightly resembled that of the present. The Amphibia, water-living, slow, dependent on seasonal return to the swamps to procreate their kind, were the giants of their day. Great changes in many parts of the world at the end of the Palezoic Era appear to have proved disastrous to the crawling, sluggish amphibians. The large ones died off and their kind is represented today only by the frogs, toads, newts and salamanders, remnants of a discouraged race.

On the late Palezoic highlands somewhere, the reptiles, better able to survive such crises as seasonal aridity, evolved from some progressive type of amphibian. These early reptiles gave rise to a branch of small, light, running creatures which were bipedal in habit. They favored the use of their hind legs and ran as the running birds do, and through the ages that followed many dinosaurs retained this habit. The front legs of many of the huge dinosaurs remained weak, useful for holding prey, rather than for support of the body.

In time the dinosaurs, under the impress of competition among themselves, radiated into all modes of living. Some, indeed, went into the trees. Some, the plant-eating types, sought safety from the meat-eating dinosaurs by going into the depths of the great Mesozoic swamps and there attained huge size and probably were left quite undisturbed due to the prestige of sheer bulk. Some became fast runners and others were slow-moving and depended on strange armor, such as horns on the head, spikes on the tail, and even plates along the spine to turn away their enemies.

The dinosaurs at various times roamed over much of the earth's surface. Their fossil remains are found throughout North America, from New Jersey to the far west, from the coastal plain of Alabama to the Peace River country in Canada. Their bones are found in Europe and Mongolia. They did migrate along the shores of the seas but there were no marine dinosaurs. Some of the reptilian crowd, however, did go to the sea and developed into the huge mosasaurs and plesiosaurs which became true terrors of the deep.

From time to time branches of the great race died off, never to return, but other dinosaurs took their place. Finally, in late Cretaceous time, pos-

The broad tongue of Athabaska Glacier is a familiar sight to the traveler in the Canadian Rockies. This view, down glacier, however, has seldom been photographed. The crevasses mark the second ice fall. The glacier issues from the Columbia Icefield, "hydrographic apex of Canada."
—Photo by Harry Rowed, Jasper.

sibly somewhere to the south where certain dinosaurs lingered on later than elsewhere, the last of the dinosaurs crawled into some jungle recess and gave up his reptilian ghost. A new day was dawning for new forms of life.

What caused the dinosaurs to die off? They were remarkably successful in many modes of life. They were perfectly adapted for life *in their time*. Some of them attained great size such as has never been exceeded among living things except one kind of living whale. Reptiles continue to grow as long as they live, and some of the dinosaurs no doubt were reptilian Methuselahs.

We should remember, however, that not *all* of the reptilian orders died off. We still have with us representatives of four orders of the 15 orders of reptiles which existed in the Mesozoic Era — the snakes and lizards, the crocodiles and alligators, the turtles and tortoises, and that strange "living fossil" with its "third eye," *Sphenodon*, now maintaining a lonely hold on life and rigidly protected by law, on St. Stephen's Island, off the coast of New Zealand. But none of these forms is dominant among living creatures. All have restricted habitats.

We cannot attribute dinosaurian extinction to one cause, because dinosaurs lived all over the world in highly varied surroundings and were of many different types. Was the cause pandemic, a world-wide epidemic of some kind? If that were true, why did some of the reptiles of other orders live on? Probably something affected dinosaur breeding. But what? Physiologists have found that an increase in heat may prove detrimental to the reproductive powers. Lizards today keep out of the hot sun. Rattlesnakes soon die of "sunstroke." Excessive heat could have killed the large dinosaurs which could not find protective cover.

As has been pointed out, extinction was not a sudden thing. Some branches lived on millions of years after other branches of the dinosaurian stem died out.

Perhaps small mammals, gnawing creatures, killed off entire races of dinosaurs by eating the eggs of the huge reptiles. We know that vast hordes of rodents existed during the end of dinosaur time. But not all dinosaurs were egg layers.

Was it brain over brawn? Some of the huge dinosaurs had brains smaller than those of kittens. One huge dinosaur has an expansion of the spinal cord at the hips, an "after brain" which controlled some of the posterior functions of the great reptile. We must remember, too, that reptiles are cold-blooded. The coming of zonal climate after the mountain-building revolution that ended Mesozoic time restricted the dinosaurs to a much smaller range. And huge reptiles could not hibernate as snakes and turtles do in our part of the world today.

Perhaps glandular disturbances were a factor. The pituitary gland controls growth. Did the pituitary of some of the dinosaurs run amok, so to speak, and cause giantism? The phenomena of giantism often precedes extinction. The fossil record shows this.

It is obvious that many of the dinosaurs became too highly specialized and that when conditions changed they could not meet them. There was no road back.

The dinosaurs were not the only great race which passed from the earth, never to return. There are numerous races of corals which are known only as fossils and likewise many groups of sea animals called brachiopods. All of the trilobites, joint-legged marine animals, have long been extinct. The ammonites, cousins of the chambered nautilus, disappeared about the same time the dinosaurs became extinct.

The biologists affirm that there is such a thing as racial old age, and paleontology provides ample evidence of this. The line becomes old and then dies out. We may well look into our own racial life. No race of vertebrates is immortal, in the sense that it has lived from the beginning of the vertebrate line.

Giantism already has appeared among the primates, for man is a giant among primates, and giantism seems to precede extinction among both the invertebrates and the vertebrates, the animals with backbones.

Man shows other signs of racial old age. Inability to get along with others of one's group is a symptom of racial decline. Very likely, then, some new form of life someday will study the remains of man, if any can be found, and conjecture, as we do about the dinosaurs, regarding the causes of extinction.

HISTORY IN JADE

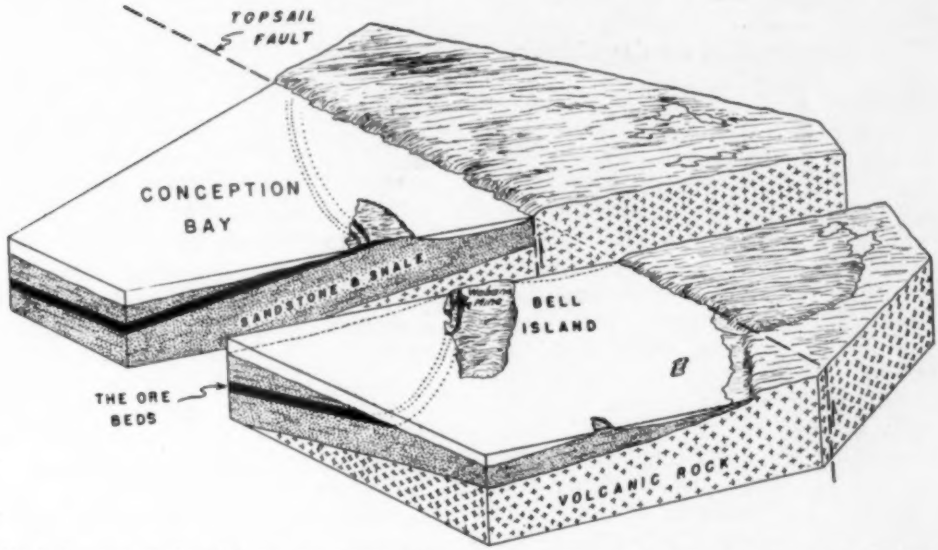
Searching among pre-historic stone records I came into possession of some Chinese seals — jade seals of the sort that have added much to known history and fixed the date of the Chinese dynasties from the beginning. Though among my Chinese seals are many exquisite pieces of lapis, agate and chalcedony, the jade seals from the first appealed to me most, both for their intrinsic beauty and for the long culture they represented. It is quite likely, historians tell us, that the first of all the world's written history is recorded in the jade pieces of ancient China. Its rituals for worshipping one God are told in the tomb pieces of that land, and all that we shall ever know, very likely, of man's earliest great culture is told in the votive and ceremonial jade pieces which come down to us from a time otherwise unrecorded.

—James Lewis Kraft in *Adventures in Jade.*

IRON FROM UNDER THE SEA

Newfoundland Miners Work Hematite Deposits One Hundred Fathoms Beneath Atlantic

JOHN JESSE HAYES
University of Michigan



Block diagram of the Wabana iron deposit, Newfoundland, showing location of mine on Bell Island.
(Modified from A. O. Hayes, Econ. Geol., 1931)

The "Great Island", Newfoundland, is roughly hatchet-haped and covers nearly as much area as all the New England states together. Its wave-cut eastern coast, deeply indented by great bays, lies closer to Europe than any other part of the North American continent. A few miles from St. John's, the capitol, is Conception Bay, the southernmost of these broad extensions of the sea, which has in its eastern part a small bit of land called Bell Island. On the island is a locality appropriately named Wabana — "the place where daylight first appears" — and the site of one of the world's most unusual mining enterprises.

For nearly fifty years hematite, the red ore of iron, has been extracted in millions of tons from this deposit. It was originally mined on the island where the ore beds crop out at the surface. With exhaustion of the accessible surface supply, the pursuit of ore was carried out by following the gently sloping iron-bearing formation as it dipped northward into the ground. At present it is mined in complex workings far below the bottom of the bay. Submarine slopes have been driven more than two miles from shore and in places are covered by nearly 2,000 feet of rock and 600 feet of water.

The ore occurs in three main beds, one above the other. In the accompanying diagram they are grouped as a single black band. The lowest one, called the Lower (or Dominion) bed is from 15 to 30 feet thick and lies on top of a great series of shales and sandstones of Cambrian age. The Middle (or Scotia) bed lies 240 feet above it, is about eight feet thick, and contains a very high grade of ore. Sixty feet above this is the last and Upper bed, varying from five to eight feet in thickness and is the least productive of the three. In many places the Upper bed is split by layers of sandstone and shale into bands too thin for mining.

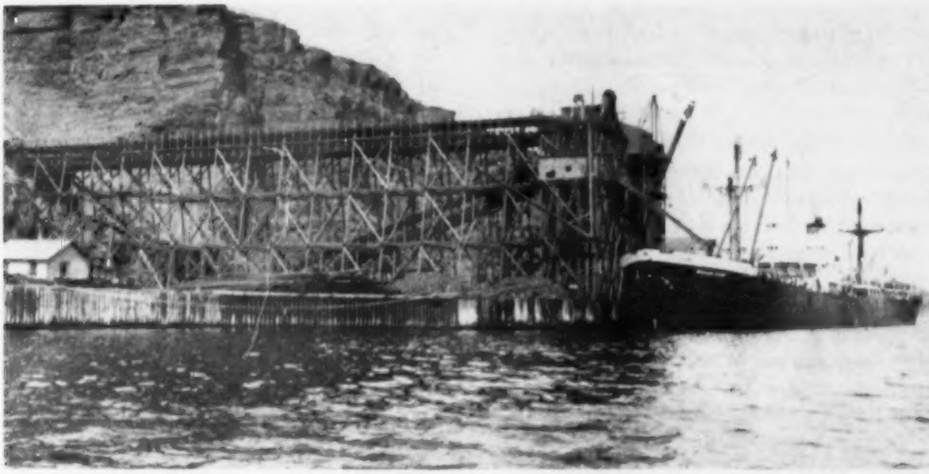
As may be seen in the diagram, the ore crops out at only one place above sea level, although it probably has an extensive submarine outcrop indicated by the three parallel dotted lines. The reason that it does not appear on the nearby main island is made clear when the significance of the Topsail Fault is understood. A great mass of volcanic rock underlies the shale and sandstone series. When the fracturing and vertical movements of the fault occurred, the mainland side was moved upward with respect to the seaward side, truncating the sandstone, shale and ore-bed sequence and bringing the volcanics up past the sedimentary rocks. The amount of movement was measurable in thousands of feet and must have taken place over a long period of time. Thus the original eastward extension of the ore beds, if it was present, has long since been removed by erosion.

Like that of many other mines, the story of the Wabana discovery is one of chance. People were living on Bell Island and around the shores of Conception Bay as long ago as 1611. Many a small fishing boat on the way to or from the rich Newfoundland banks, passed close-hauled against the Atlantic gales in the lee of the island's cliffs, its crew unaware of the treasure exposed to view. The dark red-brown bands interbedded with light-colored sandstones and black shales meant no more than a familiar landmark, or a place where they might get unusually heavy rocks to use as anchor weights and ballast. The first recorded mention of the ore beds was made in 1842, when a man named J. B. Jukes conducted a general survey of Newfoundland's geology and wrote of a "bed of bright red sandstone about eight feet thick" on the northwest side of the island. He committed the geologist's cardinal sin by staying in his boat and neglecting to "knock a rock" of which he was not sure.

It was not until 1892 that an observing merchant in St. John's, whose name is lost to the history of geology, noted the great weight of the blocks of ballast being discharged from a schooner and had the curiosity to find out more about them.

Once it was recognized as an important iron source, Wabana became a place of great activity. The property was purchased by the Nova Scotia Steel and Coal Company and pioneer development was begun under the direction of R. E. Chambers. Mr. Chambers was the first to recognize the immense possibilities of the submarine ore. In 1899 a portion of the area was acquired by the Dominion Iron and Steel Company, whose holdings included the Lower bed. The Upper bed was held by the Nova Scotia company. Additional underwater claims were staked by the two organizations until they together held nearly 150 square miles of land below the sea. At the present time there are four mines all being operated under the management of the Dominion Steel and Coal Corporation.

The method of mining is an elaborate one. Equipped with the most modern machines, ventilating equipment and skilled personnel using electricity almost exclusively for power, the submarine workings are still being extended. As the face of the ore beds is removed by means of drills, explosives, and power shovels, and more ore is known to be ahead, great supporting pillars of untouched ore are left behind to prevent collapse of the roof. These vary in size and



Ore being loaded from pier at base of Lower Ordovician cliffs on Bell Island, Newfoundland.
—Photo courtesy J. B. Gilliatt, Dominion Steel and Coal Corp.

shape, depending upon the amount of overburden, and increase in number the farther the operations are carried. Each is left with a generous margin of safety, and are later carefully trimmed to yield more ore after general mining in the area is completed. Mining is not attempted where the overlying rock is less than 200 feet thick, for a break allowing the entrance of the sea would have tragic results. Beds four feet or less in thickness are considered too thin to mine economically.

Cracked and sheared by past earth movements, the ore shatters readily into angular blocks of convenient shape. It is loaded into cars and hauled by cable tramway up the long incline to the surface. Elaborate loading facilities, built to accommodate the largest freighters, have been erected on the south shore of the island. Here the ships come in close to the high, abrupt cliffs and receive cargo from the huge loading piers towering above them.

During the early part of a period of time, perhaps some 400 million years ago, which geologists call the Ordovician, the areas of land and sea bore no resemblance to their present outlines. They were changing then, as they are changing now, with inconceivable slowness, consuming millions of years in the process. Time and again shallow seas crept over parts of what is now North America only to recede as the land rose beneath them. With each withdrawal they left behind a record of their visit in the form of thousands of feet of layered sands, muds, and lime. It was on the shore of one of these temporary oceans that the iron ore of Wabana had its origin.

Close examination of the ore shows it to be composed of minute spheres of hematite, varying in size from one-half to one-tenth of a millimeter, and resembling fine sand. The grains are so closely packed together that many of them are flattened to a disc-shape, indicating that they were squeezed together while still plastic and not long after they were formed.

There can be little doubt that these small concretions, or oolites, as they are often called, were laid down and sorted under shallow-water conditions in a salty sea. Perfectly preserved fragments and whole shells of small marine bivalves are found everywhere in the ore. Many of them are riddled with the holes left by microscopic boring algae, primitive sea weeds. Numerous shells of trilobites, the small armored crustaceans so abundant in the Ordovician seas, as well as the trails left by them as they crept over the sea bottom, are found.

In some places the past action of waves and currents is shown where cross-bedding was developed as the hematite spherules were piled up into sand bars, and by the presence of casts and molds of ripple-marks. In other places, layers of common quartz sand were spread out over the iron sand during storms, later to consolidate and form the "parting rocks", characteristic of the Upper Bed. Evidence that the ore sand was subjected intermittently to the air by the rise and fall of tides is recorded by the raindrop impressions found molded in the iron.

The source of the iron ore is rather difficult to explain. Dr. A. O. Hayes of Rutgers University, who has studied the structure and origin of the Wabana ore in very great detail, has shown that chamosite, a heavy, green-colored silicate of iron was the first mineral to form, probably as a chemically precipitated, jelly-like mud, which under very shallow conditions or by exposure to air during low tide, was oxidized to form part of the hematite. More hematite may have been precipitated from iron brought from the land by streams in a dissolved form or as minute grains of iron compounds. These particles, by reason of their superior weight, would sink to the bottom, combine with the ammonia formed by decaying matter, and be later oxidized to hematite by action of the abundant algae. If most of the ore was derived from the chemical break-down of the chamosite, a great deal more silicate material would be expected in the ore beds than is actually found. Dr. Hayes has suggested that the residual silicate material may have been a very light, flocculent material which would easily have been floated away by currents. Lastly, an iron carbonate mineral, siderite, was developed here and there, possibly by the action of decaying plant and animal matter mixed in with the bottom muds.

After ore deposition, the sea bottom was lowered even more until deep-sea conditions prevailed. That this occurred is attested by the presence of fragile fossils of graptolites, a form of free-floating marine life, typically found in deep-water deposits of this time. In addition, the upper beds show a lack of the iron oxide which required a shallow environment for its formation. As this subsidence went on, more sediments of various kinds were laid on top of the ore beds to consolidate and preserve them, until ages later, the sea bottom was uplifted, folded, faulted and dissected by weathering to expose the ore in its present form.

The economic importance of Wabana is considerable. The presence of this one deposit alone would be enough to make the oldest colony in the British Empire, Newfoundland, a valuable one. The annual production in ore shipments is about two million tons. Estimates on the amount of ore available for future exploitation vary, depending upon conditions, which cannot be proved in advance of mining, but even the most conservative figures are startling. They range from two and one-half to ten billion tons — enough to last for well over a thousand years even though the present rate of production were greatly increased.

The author, in writing this, has drawn freely from the work of Dr. A. O. Hayes, whose exhaustive research on Wabana remains as the most authoritative work yet done on these deposits. Additional material was acquired from publications by Dr. A. K. Snelgrove, former head of the Newfoundland Geological Survey, and of Mr. J. B. Gilliatt, chief engineer of the Dominion Steel and Coal Corporation.

EDITORIAL

How can appreciation of geology be widened and deepened among the amateur and hobbyist?

The question has been asked many times through the years and several leaders in the science have offered their suggestions. Prof. Chester R. Longwell summarized current opinion and added some ideas of his own in a paper in *Science* (Vol. 101).

We quote from his statement:

" . . . The most helpful program of public education in geology looks beyond government officials, military leaders and other important special elements of society. Our goal should be the widest possible dissemination of geologic information. . . .

"Geology has a large asset in widespread appeal of visible geologic features. Cultivation of this natural interest will be a valuable contribution to cultural education in a materialistic age. . . . When geologists are ready to give unified and systematic attention to this large and important problem, they will demonstrate that the science in this country is really becoming of age."

Soon after this paper appeared, *The Earth Science Digest* was established. The response of the profession has been most gratifying. Members of the Geological Society of America have offered counsel and have contributed popular articles. On the occasion of the 60th Annual Meeting of the GSA, *The Digest* extends its best wishes.

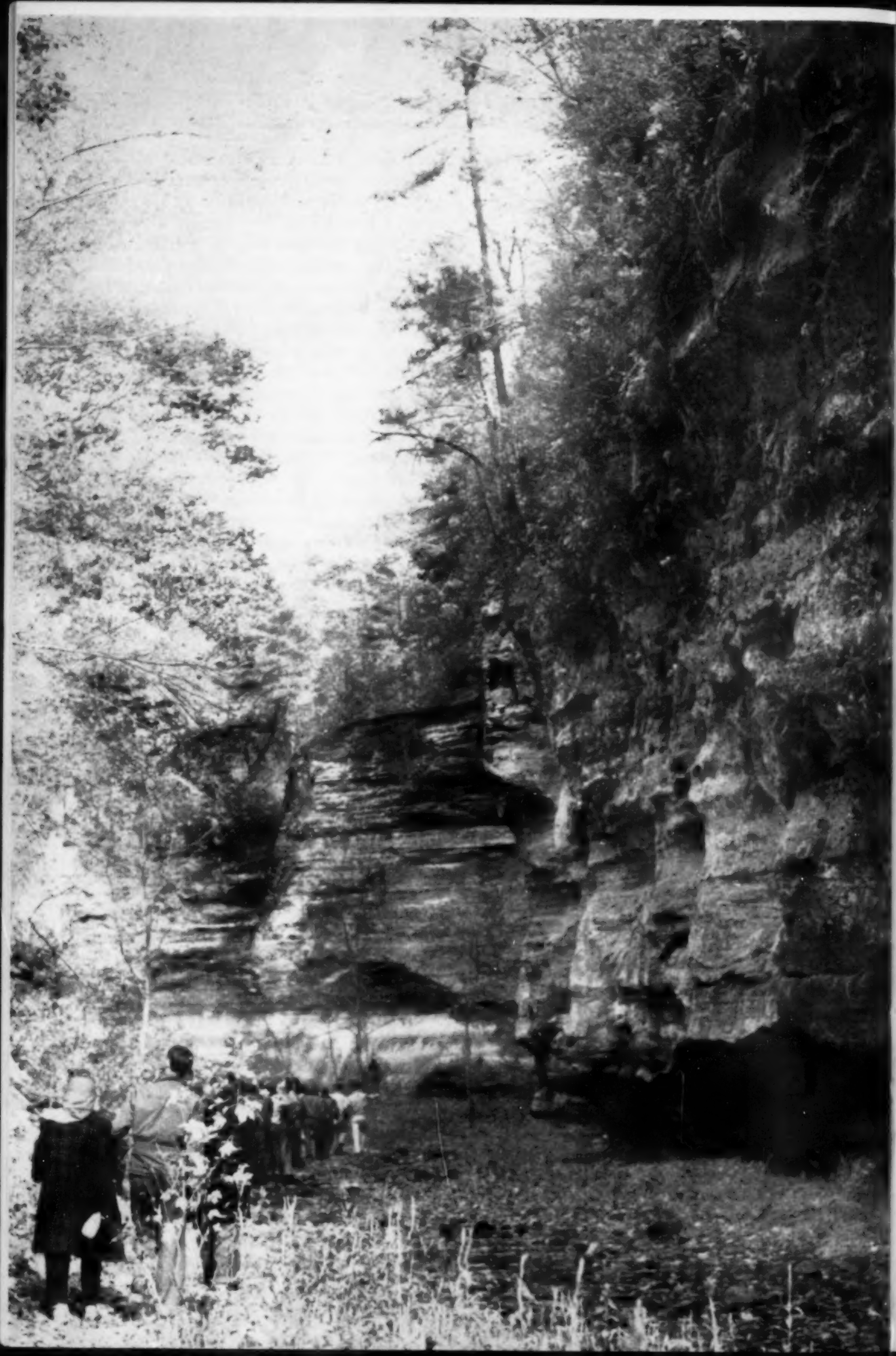
COVER PHOTO

The young geologist photographing the classic panorama of California's Yosemite Valley epitomizes a significant trend in geology — the ever-widening use of the "third eye" of the earth sciences, the camera lens. In the distance rises Half Dome, viewed by thousands every year and well known from photos by students of geology everywhere. The valley, seven miles long and a mile wide, lies 3,000 feet below the surrounding surface and is noted for its hanging tributary valleys from which issue the famous Bridal Veil and Yosemite Falls. Yosemite owes its beauty in large part to Ice Age glaciers moving down the old gorge of the Merced river, which gouged out a great U-shaped valley. The work of the slow moving ice was facilitated where huge and closely spaced cracks, called joints, weakened the rock. Where the granite was resistant however, due to the absence of joints, huge masses of rock withstood the action of the ice, Half Dome and El Capitan thus dominate the Yosemite landscape today.

WITH THE CLUBS

Members of the Oklahoma Geological Survey and the geology faculty of Oklahoma University were host to the Oklahoma Mineral and Gem Society at the university. Prof. J. W. Stovall, director of the university museum, introduced Dr. Hugh D. Miser of the United States Geological Survey, who gave a talk on Arkansas quartz crystals, illustrated with slides and specimens.

Los Angeles Lapidary Society was entertained by a lecture on Yellowstone National Park by William Sandborn, park naturalist and geologist, who showed color slides and described the park's fossil trees and other mineral localities. Society members were also guests of the Searles Lake Mineral and Gem Society for two days at Trona. The program included the annual hobby and mineral show and banquet. Diamond cutting was described at the monthly meeting of the Faceteers by Sam Wagonaar, of Amsterdam, Netherlands.



Earth Science in the Secondary Schools

A Leader in the Program Discusses Situation— Asks Cooperation of Universities, State Surveys

BEN HUR WILSON

"Youth today, citizen tomorrow—
World education
May save them much sorrow."
GEORGE R. WELLS

A question which we are frequently asked and one which we often mull around in our mind is: Why is not more Earth Science being taught in the secondary schools of America? We only wish we knew the entire answer. In part, however, I would say that it is largely because those who are sold on it and believe in it most thoroughly do not, as a rule, go to bat for it and put up a fight to get it incorporated into the school curriculum.

In spite of the fact that it is the most basic of all sciences, and the one which could contribute most to the cultural welfare of the individual in the field of intelligent and useful living, educators in general sit complacently by, seeming to be wholly unaware of its great possibilities, and, therefore, do little or nothing about it. This condition must be speedily changed. The preparation for citizenship in a modern world demands it.

The author of this article is head of the Earth Science Department of Joliet Township High School and Junior College, Joliet, Illinois. The department is probably the largest in the United States and Mr. Wilson's lecture room was the first Earth Science laboratory established in the secondary schools in America. Mr. Wilson is president of the American Federation of Mineralogical Societies.

Students of Joliet Township High School and Junior College on geology field trip in ravine cut into the St. Peter sandstone (Silurian) in Matthieson State Park, Illinois.
—Photo by Richard Smolich.

It appears to the writer that the greatest stumbling block to immediate widespread introduction of Earth Science studies is the lack of adequately trained teachers in the field. In our own department at Joliet where, for example, over a period of nearly fifty years, we have employed on an average, about ten full time instructors, many have had to be trained within the department itself. Here, then, it seems, is a definite challenge and problem to which we must look to our teacher training colleges for solution. There are many who feel that in the immediate past, perhaps, too much attention has been given to the so-called frills of popular education, at the expense of other more stable subjects, which in the long run might possibly accomplish a great deal more good.

"Erdkunde", that is Earth Knowledge, early became a favorite subject in the schools of Europe, even before many of the other sciences developed. In this country, however, for some reason it got off to a poor start so far as the secondary schools are concerned. Some think that this was partly due to the unfortunate use of the name Physiography, the meaning of which not being well understood, caused many pupils, as well as administrators, to shy away from the subject. The newer term "Earth Science" insofar as its present usage is concerned, more clearly defines the modern subject and brings its true meaning out into the open. This seems to have had a wholesome effect upon its rapidly increasing popularity and acceptance.

Earth Science is a comprehensive, composite term which embraces all such subjects concerned with the physical and dynamic Earth. This would include physiography, geography, and certain phases of the geological sciences. It is, therefore, one of the broadest of subjects, and by reason of the great breadth and versatility of its content can easily be made one of the most interesting subjects in the entire school curriculum. It, too, is a subject which lends itself readily to any and every local situation, and one need not go far away from his own classroom to find many excellent examples for study. In this respect, it has for most students a great carry over value into their actual living experience, which is always one of the best recommendations for any subject.

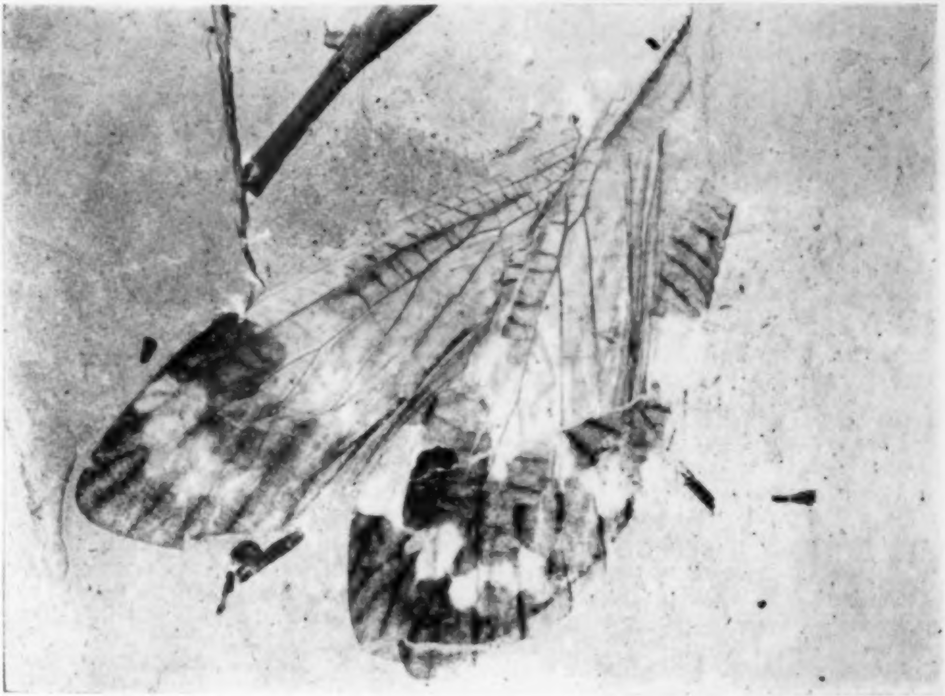
While we feel that nothing need be said in defense of Earth Science, we do believe, on the other hand, that it has a great deal to recommend it. To begin with, the Earth being definitely our home, in a larger sense, for the duration of our natural lifetime, we should come to know it intimately from every possible angle, just as we should want to become fully acquainted with our own local home and its physical environment. Through the study of Earth Science, we should arrive at an awareness that we actually know the Earth, and likewise into a realization that we are a part of it and it is a part of us, and that we should live in complete harmony with it. This in itself should make for better and more satisfactory living.

Furthermore, we are indebted to the Earth for all of our natural resources. In other words, for all that we are, have, or make use of. It is that vast storehouse from which we derive, either directly or indirectly, all of our food, shelter, and raiment, as well as our oil, fuel, building materials, and the raw materials for all of our industries. Is it not natural to assume, then, that anyone who goes through life without a true understanding of all this and how it came about, must be unnecessarily handicapped in his thinking and in the method of his attack on and solution of the problems of life? This alone is reason enough for the universal adoption of an elementary course in Earth Science in all secondary schools.

Aside from these benefits, there are other more academic reasons for which I would recommend it. As an orientation or beginning course on entering high school, there is nothing that can equal it. It has in it the elements which involve reading with understanding and expressing oneself in writing with exactness and clarity. There is enough in the historical background of the subject to create a wholesome interest in man's past. Enough mathematics is present to afford a review and a reasonable promise that it will instill in the students a realization of its practicability, for which many at that age can see no particular use.

Insofar as a necessary introduction and background for the other natural sciences is concerned, it seems most indispensable. In our studies at Joliet of the "Earth as a Planet" and its relationship to the rest of the Universe, we have an excellent preview of Astronomy. In our study of the "Rocks and Materials of the Earth's Crust", we give the student a preliminary approach to the subject of Chemistry. This is likewise done in our study of the "Nature of the Atmosphere and Natural Balances", which also gives us an introduction to Meteorology. And finally the teaching of the dynamics of "Weath-

FOSSIL INSECTS FROM MONTANA



Among the remarkably well-preserved fossil insects discovered last season in Montana by University of Michigan paleontologists is this lace-wing, or "fish" fly. The veination and color pattern of two wings show clearly. The other object, extending to the fracture in the rock, is part of the leg of a locust. The shales in which the insects were found are believed to be of Miocene age, deposited approximately 20 million years ago. The collection is in the Museum of Paleontology at Ann Arbor. —McGill Science Photo.

ering, Erosion, Transportation, and Deposition of Earth Materials" leads us a long way through the ramification of the physical sciences.

I believe that we should be able to convince even the most skeptical of the value and disirability of expanding the teaching of Earth Science. The outline of subject matter, methods and manner of presentation are things which we are not concerned with in this paper. The big question before us at present is how to get more Earth Science in the secondary schools, and this no doubt can be done in a variety of ways. For one thing, a great deal more inspirational work will have to be done on the part of all who are vitally interested, which includes specifically the geologists of our universities, our societies, and hobbyists, who often have even more influence over local situations. We need the encouragement of our State Geological Surveys and the authors and publishers of texts, maps, and other teaching materials. This is not a one man job, but one on which we should all pull together. With proper cooperation, the next ten years should see a complete reversal of the present attitude toward Earth Science in the secondary schools of America.

The Story in Rocks

The aim and end of all geological study is not merely to tell us what rocks are like, but to enable us when we look at a rock to say how and where it was formed. When we can do this, Geology becomes not a mere catalogue of dry descriptions, but a history; and we learn to look upon rocks as the pages of a volume, in which is written an account of what was going on while they were being formed. A. H. Green.
(Courtesy *Rocks and Rock Minerals*, Pirsson and Knopf.)

LETTERS TO THE EDITOR

Editor, Earth Science Digest.

I was much interested in the item in the November issue about oil in geodes. Last April, I received a geode from S. M. Snyder, of Matamora, Ill. It was split in two parts and a bottle containing the oil which had been inside was sent with it. The geode was about three inches in outside diameter and the amount of oil was about two fluid ounces. The geode came from Tyson Creek, Nauvoo, Illinois.

Arthur L. Flagg,
Phoenix, Ariz.

Editor,
The Earth Science Digest.

I am renewing my subscription for two years. I have received the *Digest* from its beginning, and let me say that I hope its next year will be as good as the past one. I think it is the best magazine in its field, in that its articles are excellently done. How about some more paleontology for the "fossil bugs" among your readers?

Leo Sirota,
5303 Post Road,
Baltimore 15, Md.

Your magazine is superb and becomes better by bounds.

Paul A. Head,
Golden, Colorado.

The Earth Science Digest.

Thank you for such a fine magazine. Your articles are exceptional and educational.

Ralph Yarbrough, S1/c
Laufley Field, Pensacola, Fla.

Bringing out the molybdenite ore at Climax. The mine attained a production of 20,000 tons of ore a day during the war and Climax delivered nearly 50,000,000 pounds of molybdenum to industry in the peak year of 1943. —Earth Science Staff Photo.

The Miracle of "Moly"

One Mine Produces Half of the World's Supply Of Industry's Vital Mineral — Molybdenite

It would be stretching the point a bit too far to maintain that a single mountain in Colorado won the war for us. But it is difficult to imagine how we could have obtained sufficient quantities of tough, strong steels to keep guns firing, planes flying and the wheels of war industry turning without Mt. Bartlett's molybdenite.

Molybdenite does not often find its way to the mineral collector and the importance of this shiny, blue-gray, soft and often foliated mineral to modern life is seldom recognized. But the metallurgist would have difficulty getting along without the compounds of molybdenum whose tenacious molecules impart "creep resistance" to steels. And the chief source of the element molybdenum is molybdenite (MoS^2), the disulphide of molybdenum.

To the vagaries of Nature have been ascribed many a mineral deposit whose origin is not readily explainable. It was a most fortunate "vagary" which gave to the United States a single, tremendous deposit of molybdenite, safe in the hinterland of the Rockies, a deposit which alone provides the world with more than half of its molybdenum.

The site of the deposit is in the Mt. Bartlett area, high in the Colorado Rockies, near Fremont Pass (Alt. 11,320 feet), 13 miles from Leadville. The deposit has given rise at the town of Climax to the largest metal mining operation in Colorado, and one of the largest in the world.

The achievement of producing nearly 50 million pounds of molybdenum in a single war year won for Climax the official acclaim of the armed forces and behind this achievement lies the little-known story of "the miracle of moly."

The reward won by the small group of men who had faith years ago in the future of molybdenum has been great. (The magazine *Fortune* once estimated that each $10,000 invested in Climax at the start grew to $1,230,000 in a decade, or a return of more than 12,000 per cent). But more important to the man on the street is the effect of increased uses of molybdenum in industry—in new steels for streamlined trains and liners of the air, and in a number of unexpected uses such as a component of inks that do not smudge, in radio and radar, in oil cracking processes, and in glass and enamel pigments.

Molybdenite, which is 60 per cent metallic molybdenum and 40 per cent sulphur, crystallizes in the hexagonal system, but at Climax the crystals ordinarily are microscopic. The uniform, fine-grained character of the mineral there is exceptional and it is found concentrated at the margins of quartz veinlets in moderately altered pre-Cambrian granites.

Years ago this mineral, destined to become a critical mineral in the last war and in demand by all contestants as a substitute for tungsten and nickel, was mistaken in Colorado for galena, and later for graphite. This despite the fact that graphite is blackish and molybdenite blue-gray and gives a green streak on porcelain while the streak of graphite is shiny black.

There is a conspicuous red and brown staining of the rock in the Mt. Bartlett area and also a small amount of canary-yellow stain at the surface. The red and brown are due to oxidation of pyrites in the country rock to limonite and the yellow is the result of oxidation of molybdenite to molybdite. The yellow oxidation product was first mistaken for a silver mineral and when assays showed no silver, for sulphur.

Claims were staked on Mt. Bartlett by prospectors in 1890 when they thought the molybdenite was galena and they dropped their claims when the Colorado School of Mines reported it was a poor grade of graphite (1).

Hence it used to be a good joke at Climax, a jumping off place for prospectors during the Leadville gold boom, to send tenderfoot gold-seekers up on Mt. Bartlett, because there seemed to be nothing of value there. Two world wars changed all that, and today Climax is an important mining town while the Mt. Bartlett area is filled with abandoned gold camps.

The blue-gray mineral on Bartlett was identified in 1900 by the School of Mines as molybdenite and 14 years later options, assays and maps were offered by E. G. Heckendorf, of Denver, to the Crucible Steel Co. The reply given him, according to Heckendorf's personal account of his negotiations, was that "the time is not ripe."

In 1916 Heckendorf presented his data to Max Schott, Denver manager of the American Metal Co. An engineer and geologist for that company made a trek to Mt. Bartlett's slopes in the early winter's snow in that year. Their report and the subsequent birth of a small company marked the beginning of the climb of the Mt. Bartlett operation into the front rank of mining properties.

The first World War was then raging. It was discovered that the guns of the Germans withstood heavy firing longer than those of the Allies. Captured weapons were found to

(1) Butler, B. C., and Vanderwilt, J. W. (*Colo. Sci. Proc.* XII, 1931).

contain molybdenum as an alloying element. The "moly" was being smuggled into Germany from Norway. By 1918 the price of molybdenum had gone up to $5 a pound. The Climax company was incorporated in the same year by Schott and his associates. Still a director of the company, Schott is now living at Santa Barbara, Calif.

The company closed down after the war, but reopened in 1924. The patents of C. Harold Wills on chrome-molybdenum steels and those of Alan Kissock on the reduction of molybdenite to calcium molybdate, and the direct use of the molybdate instead of ferro-molybdenum in steel furnaces were important factors in the resumption of mining.

In 1936 the Climax operation alone produced 15 million of the world's output of 19 million pounds of molybdenum. Net profits of the company for that year were given as $5,206,000.

Early in World War II, Climax was producing about 30 million pounds of molybdenum annually and on the urging of the Government speeded up production until a new annual high of 46 million pounds was attained in 1943. With the end of the war, production slumped and the total for 1945 was slightly less than 31 million pounds. (2)

The Climax concentrates are converted at Langeloth, Pa. An intermediate product, molybdenum trioxide, now has varied uses in the oil, enamel and ink industries.

A new development is the production of "technically pure" molybdenum by means of high-temperature melts of concentrates. It has been reported that it is now feasible to obtain some 2,000 pounds of the element in a single "melt."

Beneath the storm-swept slopes of Mt. Bartlett is sufficient "moly" to take care of our industrial needs for many years. The proven and probable ore reserves at Climax were estimated recently as 260 million tons, containing a billion, six hundred million pounds of recoverable molybdenum!

What was the genesis of this remarkable ore body? Butler and Vanderwilt (1) found that the molybdenite area is one of pre-Cambrian granite in which schist inclusions and Tertiary dikes are common. A central core in which the rocks have been largely replaced by quartz is surrounded by an envelope of moderately altered rock cut in all directions by closely-spaced intersecting veinlets, composed mostly of quartz but in places containing orthoclase feldspar.

The molybdenite is chiefly concentrated at the margins of the veinlets. Fluorite is a minor constituent which occurs along the middle of the veinlets. Outward from this envelope of moderately altered rock Butler and Vanderwilt found that the veinlets became less numerous, contain less molybdenite and that the rock grades into the unaltered rock of the region.

Small pyrite veins with some chalcopyrite, sphalerite, huebnerite, topaz, quartz and fluorite cut both the highly altered central core and the moderately altered envelope containing the ore, and the surrounding zone of slightly altered rock. Serecite (a variety of muscovite mica) in veins which are apparently later than the pyritized veins occur throughout the mineralized area.

The investigators here cited infer that the Climax deposit is associated, not with the exposed dikes of the area, but with a larger, though still-concealed intrusive body whose apex has approached sufficiently near to the surface for gases liberated from it to escape through the fractured rock above.

(Continued on Page 33)

(2) *Minerals Yearbook*, U. S. Bureau of Mines, 1945.

BOOK REVIEWS

Free Gold

ARNOLD HOFFMAN

Rinehart & Co., Inc., $5.00
42[illegible] pp. Illustrated by Irwin D. Hoffman

Without Canada, the author tells his readers, humanity would be sadly deficient in gold, silver, platinum, lead, zinc, copper, nickel, and other metals. "No other geographical entity," Mr. Hoffman asserts, "offers so enormous a mineral potential . . . which to American eyes, unfamiliar with the rolling tracts of Canada, might better be understood if we envisaged a series of mining belts reaching from Atlanta to Seattle."

This is the land Voltaire once termed "a patch of snow" and the author remarks that if Voltaire were alive, he would be interested in learning that Canada's contribution of metals during the late war had much to do with the liberation of France.

It will be news to many of the readers of this volume that the Porcupine area, for example, already has produced more gold than the Cripple Creek and the Comstock lodes combined, that Canada's total production of gold is $200,000,000 annually, and that production in Ontario alone has been twice that of Alaska ever since 1911, despite Alaska's early start.

But this book is not one of statistics. "The human side of mining has been stressed throughout," the author says. "To my knowledge the success of any camp has hinged upon one or more dominating personalities without whom the northward march would have been halting and uncertain." He concludes that "we in the United States (the author is from Boston) are astonishingly uninformed, concerning our northern neighbor. If this book contributes, however modestly, toward a better understanding of Canada, then I feel that my labors have not been in vain."

This, then, is a book about a country and some of its people — about Noranda, and Flin Flon and Pickle Crow, about Noah Timmins, Johnny Dillon, and Klondike Jessie. There is meaty language aplenty and many pages of anecdotes about the colorful camps of the Shield.

The author is a veteran of the Canadian bush, as is his brother, Robert. Fresh from Harvard, they entered the wilderness 25 years ago. A third brother, Irwin, illustrator of *The Delaware* in the *Rivers of America* series, drew the sketches.

Mr. Hoffman interweaves the romance of mining with mining practice and financing. He also includes a chapter on geology, with an abbreviated time scale for the reader who has not cracked the formal texts.

As early as Agricola (1555), mining speculation, good or bad, interested the man on the street, and Mr. Hoffman tells both sides of the story of Toronto manipulation. But he points out in his chapter on "Come On, Suckers!" that "without speculation, mining would wither away. Regardless of individual ups and downs, speculation directs capital to the proper place, where everything comes from and goes in the end—the ground."

It is the author's observation that the colorful sourdough is being replaced by the trained geologist using modern scientific devices. "There is no mining camp since Cobalt (1903) which was not first pointed up by government geologists," he finds, and in this connection it is interesting to note that in 1900, J. Macintosh Bell, of the Geological Survey, made what proved the most provocative survey of all, "for while his report remained obscured for 30 years, a fortuitous study of it by Gilbert Labine resulted in the earth-shattering discovery of uranium at Great Bear Lake, which in time led to the gold discoveries at Yellowknife."

From all this the author concludes that "a fuller comprehension of ore genesis saves untold effort, time and money, besides pointing the way to new mines. Metals do not grow, as agricultural products, with yearly crops. Fresh sources must constantly be tapped to replace ores extracted, and as discovery becomes more difficult in time, society finds itself increasingly dependent upon the geologist to solve the growing problems of supply. And so, in a world whose material civilization is based on metals, the geologist is truly the indispensable man of the Twentieth Century." —H.P.Z.

Mineral Collectors Handbook

Richard M. Pearl

Mineral Book Co., $3.75
300 pp.

The author of *Popular Gemology* and co-author of *The Art of Gem Cutting* has written a very useful compendium for the rock and mineral collector which should save many a trip to the reference library. After time and effort have been spent obtaining good specimens, it is wise to protect choice specimens, and Mr. Pearl's chapter on the cleaning and preservation of mineral specimens is a revealing one. Interesting in this connection is the recital of the efforts to protect the Cranbourne meteorite, which weighed 8,227 pounds, after its removal from Australia to the British Museum. Not until it was placed in a gas-tight case, into which dry nitrogen is pumped, was it protected from disintegration.

The wide range of subjects covered in this book includes tests for the elements, fluorescent minerals, classification of meteorites, classification of minerals, gem identification with determinative tables, popular names of minerals, terms from chemistry, mineralogy and mining, and a geologic time chart. The reader may even find out how to stake a claim, and sources of maps and a directory of mineral museums in North America, Europe, South America and Australia are also provided.

When answering advertisements--please mention The Earth Science Digest.

FAMOUS LOST MINES

(Eighth of a Series)

VICTOR SHAW

The Lost Papuan Diggings

It was in 1863 that Arizona was separated from New Mexico and made a territory. But previous to this, a military post was established for Indian control at Ehrenberg, on the east side of the Colorado River where U. S. 60 now crosses to Blythe, Calif. Trader Bill McCoy kept a store at Ehrenberg, where he stocked supplies and tools for miners, and also bartered trade goods with Mohave Indians for pack ponies, baskets, curios, and sometimes a little placer gold. McCoy was well known throughout the Southwest, so well in fact that the McCoy Range, a dozen miles west of Blythe, was named for him.

One day in 1864, a lone Indian padded quietly into his store carrying a big poke of Indian tanned buckskin. This Indian being a stranger, McCoy sized him up closely as he dumped the poke upon the counter and began looking over the goods spread out for sale. As he pawed over a pile of blankets, McCoy stealthily felt of the poke and realized it was jamful of gold nuggets. The Mohave's gold never was anything like this, and he was sure this buck wasn't of that tribe. He was taller, and his face looked as though he came of Pima stock.

While they bartered, Indian fashion, McCoy casually threw in an occasional question leading to the identity of his tribe and himself, but got only vague grunts in reply. Tactfully and persistently McCoy pressed the stranger, his curiosity seething at the size of the nuggets his customer offered in payment for the goods selected. And, when the Indian packed his pony and left, McCoy had learned that his name was Papuan and that he was a chief of the Papago tribe.

Knowing much of Papago history, McCoy understood how Papuan chanced to appear there in the Mohave tribal lands, for most of these Papagoes — survivors of past wars with the Apaches — were scattered all over the country. Probably, McCoy surmised, this chief, Papuan, was driven from his tribal country south of the Gila and had come west to make a home among the peaceable Mohaves. This being true, Papuan's hogan now must be somewhere in the desert nearby.

This proved to be a good guess, for Papuan soon appeared at frequent intervals with plenty of the same big nuggets, which he traded lavishly for whatever goods happened to strike his fancy. Apparently his supply of gold was inexhaustible, and McCoy's obsession to somehow trick Papuan into telling where he got it grew until he dreamed of little else. But in this he never succeeded. Moreover, although he is said to eventually secured as much as $75,000 of Papuan's gold, he never even learned anything of Papuan's past history.

These facts, however, have been gleaned from other sources. It has been revealed that Papuan was the last Papago chief. The Papagoes being, like the Navajo Indians, a peaceable, industrious tribe occupied chiefly in farming their little plots of land, were unable to cope with the fierce Apache warriors. And in the final bloody battle Papuan, in danger of being killed or captured, had managed to escape at night by skilfully covering his trail. Heading west by circling widely, he had reached the Mohave country along the Great River, the only tribe that never had made war against his people.

Papuan had made his escape alone, his only possessions being what he could load on his pack pony. But he knew he had no cause for worry, for most of his pack load was nugget gold, which he had gathered from a secret place he had discovered many years before. He found the Mohaves friendly enough, when he arrived. He was not molested in any way, for they were too much engaged with their own affairs to bother with a lone stranger from another tribe.

For a chief, always waited on hand and foot, the matter of living alone and doing for himself proved decidedly uncomfortable. So he looked around for a squaw to take care of domestic drudgery and by good fortune found one living by herself, no doubt because her youth had passed long since. But, as she was willing to take up with him, they were married with customary tribal rites and his troubles ended.

When he found that she was devoted and agreed it was better that they live by themselves, he took her along when he rode back to replenish his store of gold, knowing she'd never betray his secret. It was noticed that they often rode into the desert together, to be gone for weeks at a time, but they never told where they went. And they always brought back a load of gold. A little was presented to a few of the Mohave chiefs, but most of it was traded for goods at McCoy's store and the news got around. Everyone wondered where it came from.

Bill McCoy was in the best position and tried by every wile he knew or could invent to learn Papuan's secret. When many favors and offers of rich reward failed, he threatened dire misery and misfortune that was certain to come, only to be stolidly ignored. As a last resort, he sent out well known trackers to follow Papuan and his squaw, but they returned beaten, saying Papuan was too clever for them.

So it went for two years, until in 1866 the Apache warriors moved west and began their fierce raids on the Mohave Indians, which enraged the peaceful tribe to the point where they organized the whole nation in a tribal war against these enemies. Papuan, who had always been a famous warrior among his people, joined his Mohave friends to help drive the invaders off their land, and in one bloody engagement he was killed. The Mohaves were badly defeated with many killed or captured, but Papuan's squaw managed somehow to get safely away, thus leaving her the only one who knew Papuan's secret — so everyone thought.

Meanwhile, the news of Papuan's rich placer naturally had swept all over the Southwest. Countless attempts to find it were made, but all were handicapped at the start by not knowing where to search. Papuan's squaw alone held the secret. So a search was made. Her hiding place was discovered, but nothing induced her to talk.

Then, about ten years later as report has it, a man named Hartman appeared in Erhenberg and quietly began to question everyone about the Papuan placer diggings he had heard reported. He was a German — odd how they pop up in most lost mine tales — a man of powerful build but suave manner and about fifty years old. He had no trouble learning all about Papuan's squaw, although by this time few knew just where she could be found. Anyway, he is said to have made a search to find her living alone, gray haired and feeble, with her wrinkled face resembling the withered meat of a dried-out walnut.

Apparently this just suited Hartman, for he at once commenced to take care of her, evidently to earn her gratitude. For months he saw to it that she lacked for nothing, bringing her gifts of various kinds of nourishing thick soups and rich foods, also warm blankets, articles of clothing, even trinkets and gewgaws that delight any squaw. All these she accepted with grim stoicism, saying nothing.

Before long he began gently pressing her to reveal the thing he so longed to hear; but although he never relaxed his ministrations, he got no thanks and she turned a deaf ear to all his questions. This went on and on without a break, until he had about given up hope; then one day she suddenly told him to get horses to ride into the mountains.

Overjoyed at his success, he was busily getting an outfit together, when she was stricken by a severe cold which swiftly became worse, with high fever and chest pains. Hastily, he summoned a doctor, who diagnosed pneumonia and said she couldn't possibly recover. Very soon she became delirious and soon died. But Hartman didn't lose all hope, for during a lucid interval before she died, she swore there was one other who knew Papuan's secret. Find Chinkinnow, she told him. He was Papuan's adopted son and went with him several times to that hidden place of much gold. Maybe he will take you there. No doubt Hartman was pleased that his well laid plan had won. What a bequest!

At any rate, sure of his powers and persistent, he tackled this new job with Teuton confidence. The stake involved was worth a year or so of hard work. Even if it meant breaking down the traditional Indian taciturnity, there were ways to solve even that problem.

He easily tracked down Chinkinnow, a young Mohave tribesman well known there and who was willing to talk, but he ran against something he hadn't anticipated: traditional Indian superstition. Right away he found that Chinkinnow had an abounding knowledge and fear of the invisible spirit world. That in this case, he couldn't be moved, for the spirits guarding Papuan's treasure would surely be angered and would wreak vengence upon any who violated the now sacred domain.

For weeks Hartman is said to have worked to prove the folly of Chinkinnow's primitive dread and got nowhere. And riches, Chinkinnow said were worth nothing if the spirits seized him, so he stood firm in refusal. At last Hartman had a brilliant idea, and told the young Indian that he had a potent "medicine" that would cow all spirits and make them do his bidding. He would make them leave and all would be well, for then they wouldn't know Chinkinnow was there.

This broke down the Indian's resistence and after outfitting for a long pack trip, he led Hartman out across the desert in a southeasterly direction heading, he said, for the south end of Papuan's mountain. Then followed the usual sun-blasted trek through a land lacking any natural water resource, where they must ration their all too short supply carried in several oversize canteens wrapped in folds of old blankets. Chinkinnow had said there was no water in this land.

As they pressed on deeper into the scorching maze of dunes, where wind-whipped dust devils whirled in ghostly revelry, it suddenly dawned on Hartman that for some reason his swarthy guide was becoming unduly restless. And watching, as each mile followed slow plodding mile, he thought the Indian's uneasiness increased. Oddly the fellow's brown face had turned a queer claylike hue, as if his streaming sweat had washed out its natural color. Much later, Hartman said he then was suspicious but kept quiet, hoping he was wrong.

Then late one afternoon, lying low along the far horizon, Hartman saw what at first he took for a purple rain cloud. Next, he thought it a mirage; but as it remained unchanged and in outline began to look like a desert hill, he asked Chinkinnow if yonder mountain was their destination. But his guide, slouching as usual in the saddle, merely stared glumly ahead without replying.

Slowly the mountain seemed to draw closer and to alter color. Its former blank blue merged into shades of natural browns and reds, its craggy flanks seamed by shadowy canyon and gulch; and presently, as they halted to make camp at a chance clump of palo verde, Hartman's spirits rose, for he felt sure Papuan's mountain lay only a few miles ahead and could easily be reached the next day.

But, then disaster fell. While his guide unpacked, Hartman was busy getting dry mesquite for a fire, when he heard a sharp exclamation from his guide and asked if anything was wrong. Chinkinnow seemed alarmed to the point of weeping, as he explained that somehow their water cans had been leaking; and, when Hartman hastily investigated, he was stunned to find there remained hardly water enough to last them back to Erhenberg. Calamity on the eve of success!

Controlling his rage, Hartman dourly studied the chapfallen Indian, who he was sure had somehow contrived this mishap. Overcome by fear, he had taken this step to avoid entering this spirit haunted treasure mountain. Yet Hartman realized that his own lack of vigilence had given his guide the opportunity. So he merely dryly remarked that this meant they must return for more water starting at once. Chinkinnow, silent as usual, merely shrugged and nodded.

Back at Ehrenberg, Hartman was little surprised when Chinkinnow couldn't be persuaded to again venture into that spirit guarded locality. Indeed, the Indian seemed to believe that the paleface medicine was no good, thus allowing the ghostly guardians to steal their water. Hence, seeing that further argument was useless, Hartman loaded more water and supplies and set out alone, intending to reach Papuan's mountain before the sweeping wind wiped out their trail.

The winds were gentle and his plan succeeded; but though he conducted a thorough search as long as his water lasted, he found no trace of what he sought. Those rugged canyons are steep and most of them serve like natural chutes for raging torrents in the rainy periods, and the annual freshets leave the bedrock bare and polished. And probably having but a rudimentary knowledge of economic geology, it is not surprising that Hartman's quest failed.

But wiley Chinkinnow, who had been paid in advance, began to make good use of this easy and profitable scheme, which he had proved to be practically hole-proof. Even the proper trail need not be followed, for mountains were plentiful all over the desert, and the gold crazy palefaces crowded in like hungry cattle in winter storms. And the shrewd Indian guided them off into the trackless desert — at stiff prices laid on the barrel head. Yet you'll still find old-timers, who sagely wink, wondering if habit made Chinkinnow always head southeast.

These sun dried old desert rats argue Papuan's placer must be in the mountain, for winter freshets would wash only flour gold in the desert, thus leaving the heavy gold in the hills. In which supposition they are quite correct, for with all placers the heaviest gold always remains fairly close to the parent vein from which it derives.

Furthermore, it is quite possible that the Papuan placer may lie in an upland basin among the higher peaks, from which no "float" gold, coarse or fine, can be washed away but must remain there in situ. The size of Papuan's nuggets indicate that it came from some very rich vein, perhaps a lode of some size. Therefore, just in case, we should climb high and first hunt for that parent vein. Maybe we'll try it.

(Continued from Page 23)

For some reason which is not apparent, the escape started where the present deposit is located and, once started, continued to drain gases from the crystalline stock below. These escaping gases affected the changes in the rock and deposited the molybdenite.

Zoning in a deposit formed in such a "blow hole", Butler and Vanderwilt assert, would probably be mainly vertical and the erosion surface at any given time would show but one zone. This may be the reason, these authors say, why molybdenite is the only commercial metal found in the deposit, and the molybdenite itself is the strongest evidence of the presence of an unexposed stock.

Lab-Grown Crystals

Artificial crystals will have replaced 90 per cent of the natural quartz used in long-distance telephone systems in a few years, the Bell Telephone Laboratories report. Some of the New York to St. Louis circuits already are using the artificial crystals.

In Allentown, Pa., Western Electric has constructed a plant for mass production of the new material. The new crystals differ markedly from quartz in chemical composition but are piezo-electric in character in that they can convert mechanical energy to electrical, or the reverse.

A small slice, or plate, of such a crystal will vibrate with unvarying frequency when electric current is applied to it. Telephone engineers employ this characteristic of quartz —and now of ethylene diamine tartrate, known as EDT — in sending many telephone conversations over the same wires at one time but at different frequencies.

The new crystal is the direct result of research on growing artificial crystals. In commercial production, the artificially grown crystal weighs about a pound, is about six inches in length and two by three inches in cross-section. Full-grown crystals are cut into plates, roughly one-eighth of an inch thick, an inch-and-a-half long, and one-half inch wide. The plates are coated with a film of gold hardly one-millionth of an inch thick, which serves as an electrical connection. They are then mounted in a glass envelope to form a unit.

The first tiny seeds of crystal from which subsequent crops were harvested were only one-third of an inch across. They were obtained by evaporating a saturated solution.

"Reason dictates that the study of rocks is not a library science."

Arnold Hoffman

See Next Issue of The Digest!

Articles of interest to the mineralogist, geologist, collector, explorer, and student will include:

"Buried History"—the story of climatic change as told by fossil pollen grains. By Dr. Stanley A. Cain, Cranbrook Institute of Science.

"The Lost Gunsight Mine"—another of Victor Shaw's "Famous Lost Mines" series. And other features of general interest.

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